
Welcome Aboard
NAVAL RESEARCH LABORATORY

WELCOME

Ours is a rich and productive 80-year heritage. We opened our doors to NRL in 1923, after the famous inventor Thomas Edison recommended that a "modern research facility for the Navy" be established. In 1963, NRL was first designated the Navy's "Corporate Research and Development Laboratory." Today we continue to perform research, extending scientific and technical knowledge necessary to support a modern Navy and Marine Corps leading to future naval materials, components, sensors, and systems. Since its establishment, NRL has been involved in nearly every area of science and technology needed to help the Navy attain the advantage over potential adversaries.

First and foremost, we are people, about 2950, including over 730 PhDs, a Nobel Laureate, and many aspirants. These people are a national trust in the truest sense.

Our scientists, engineers, and support personnel work in a campus-like atmosphere that encourages interdisciplinary projects and studies. We pride ourselves on our corporate approach to meeting Navy and Marine Corps challenges. We strive to reward in many ways in addition to salary. Synergism abounds as one of our major strengths. While publications, patents, and licenses are important to recognize the accomplishments of our work, our primary mission is support of Fleet and Marine Corps operations with the fruits of first principles research and cutting edge technology.

The Laboratory is as vital and innovative today as ever. For people who place a high value on scientific and technical contributions and who put a premium on technical excellence, this is a superb place to work. Our goal is to continue to create a nurturing climate for inventiveness and productivity that supports the needs of the Naval services and our nation.

CAPT David M. Schubert, USN
Commanding Officer

Dr. John A. Montgomery
Director of Research

The Naval Research Laboratory's mission is to conduct a broadly based multidisciplinary program of scientific research and advanced technological development directed toward maritime applications of new and improved materials, techniques, and equipment; systems; ocean, atmospheric, and space sciences, and related technologies. This includes

- providing primary in-house research for the physical, engineering, space, and environmental sciences
- providing broadly based exploratory and advanced development programs in response to identified and anticipated Navy and Marine Corps needs
- providing broad multidisciplinary support to the Naval Warfare Centers
- providing space and space systems technology development and support, and
- assuming responsibility as the Navy's Corporate Laboratory.

MISSION

The Naval Research Laboratory opened its doors in 1923, seven years after it was first proposed in discussions between Secretary of the Navy Josephus Daniels and inventor Thomas A. Edison. The new laboratory boasted two divisions, Radio and Sound. Research divisions in Heat and Light (later Optics), Physical Metallurgy, Chemistry, and Mechanics and Electricity soon followed. Early research achievements included the discovery and explanation of radio skip distance; the development of the fathometer and early sonar; and the development of the first operational American radar, in time for use in World War II.

The postwar era was a time of great expansion for NRL. The Laboratory continued and added to its prewar research program in radio, radar, underwater sound, chemistry, metallurgy, and optics. However, it also added new research areas in nuclear science and cosmic rays; in upper atmosphere research, using V-2 and successor rockets; in radio astronomy; in electron and X-ray diffraction analysis of molecular structures; and in enhanced programs in antisubmarine warfare, electronic countermeasures, surface chemistry, solar physics, and more.

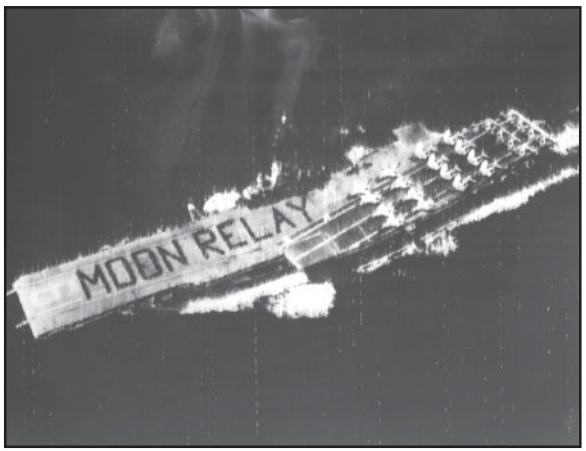
The Laboratory's Vanguard rocket project was possibly its most famous postwar R&D program. Laboratory scientists have designed, built, and launched more than 85 satellites since the late 1950s.

In the oceans, NRL's Ocean Engineering Branch, working with the Navy's Deep Submergence Project Office, acquired a worldwide reputation for searching the ocean's abyssal depths.

NRL's Laboratory for the Structure of Matter has become internationally famous for its pioneering work in using electron and X-ray diffraction methods for understanding the structure of complicated organic molecules. The Laboratory's Dr. Jerome Karle received the 1985 Nobel Prize in Chemistry for his work in this regard.

The Laboratory's current research program spans the scientific spectrum, including studies in topics as diverse as monitoring the solar corona and its impact on the Earth's atmosphere, biomolecular engineering, artificial intelligence, remote sensing, the oceanic climate, virtual reality, superconductivity, and nanoscience. Indeed, with 80 years of growth and development, NRL shines as the Navy's corporate laboratory and as one of the Federal Government's leading in-house centers for innovative research in the national interest.

Dr. E.O. Hulburt, first NRL Director of Research



First photo transmitted via the Communication Moon Relay (CMR), 1960. Shown is the USS *Hancock*.

First meeting of the Naval Consulting Board, 1915. Front row center is Thomas A. Edison and to his right is the Secretary of the Navy, Josephus Daniels.

FACILITIES

In support of its diverse programs, NRL has an impressive array of modern tools for research, many of which are unique. A sampling is listed below.

- Computational Meta Facility (CMF) consisting of scalable, massively parallel-shared memory architectures accessible by remote access:
  - Silicon Graphics Origin 2000
  - Hewlett Packard Exemplar
  - Sun Microsystems HPC Wildfire
- ATDnet Washington area POP . . . high performance, multigigabit optical DWDM streams
- Human-Computer-Interaction Laboratory
- Radar Cross Section Prediction facility
- Artificial Intelligence Center
- Central Target Simulation facility
- Versatile facilities for high magnetic field and cryogenics research
- Variety of GaAs and solid-state lasers, including devices of very high power and brightness
- Nanoelectronics processing facility
- Nike krypton-fluoride 5 kilojoule laser
- Spacecraft fabrication, assembly, and test facilities
  - Radio frequency anechoic chambers and controls
  - Shock and vibration
  - Thermal vacuum and acoustic reverberation chambers
- Satellite telemetry, tracking, and control facilities
- Infrared "anechoic" chamber
- Acoustic holography pool facility
- Mode stirred chamber for creating intense electromagnetic testing environments
- Virtual reality grotto workbenches and interaction laboratory
- Advanced distributed simulation center with HPC and ATM network
- Table-top-terrawatt (T3) laser
- Large-volume space chamber
- Laboratory for advanced material synthesis
- Molecular Beam Epitaxy Center for advanced electronic devices
- Nano Institute facilities
- Trace element mass spectrometer
- Matrix assisted pulsed laser evaporation system
- Microwave processing facility
- Rail gun system
- Space chamber
- Laboratory for Structural Acoustics
- Naval prototype optical interferometer
- Ocean dynamics and prediction network
- Electron microscopy center
- Satellite Data Ingest and Processing System
- Space instrument test facility

NRL–Stennis Space Center (Bay St. Louis, Mississippi) and NRL–Monterey (California) perform R&D in marine geology and geophysics, oceanography, and atmospheric sciences. Other NRL locations include the Chesapeake Bay Detachment in Chesapeake Beach, Maryland; two smaller Maryland sites, Pomonkey and Tilghman Island; and the Marine Corrosion Facility in Key West, Florida.

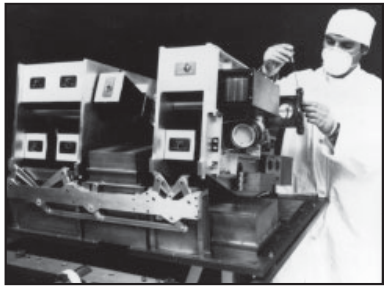
Mobile research platforms contribute greatly to NRL's research. These include six uniquely configured P-3 Orion turboprop aircraft at the Flight Support Detachment located at the Patuxent River Naval Air Station in Lexington Park, Maryland; and one ship, the ex-USS *Shadwell* (LSD-15), berthed in Mobile Bay, Alabama.

The Naval Research Laboratory is a field command under the Chief of Naval Research, who reports to the Secretary of the Navy via the Assistant Secretary of the Navy for Research, Development and Acquisition.

Heading the Laboratory with joint responsibilities are CAPT David M. Schubert, USN, Commanding Officer, and Dr. John A. Montgomery, Director of Research. Line authority passes from the Commanding Officer and the Director of Research to the Office of Program Administration and Policy Development to the research divisions. Research is performed in the following organizational units:

- Systems Directorate
- Materials Science and Component Technology Directorate
- Ocean and Atmospheric Science and Technology Directorate
- Naval Center for Space Technology.

NRL operates as a Navy Working Capital Funded activity. As an NWCF activity, all costs, including overhead, are contributed by benefiting customers. Funding in FY2002 came from the Chief of Naval Research, the Naval Systems Commands, and other Navy sources; government agencies, such as the U.S. Air Force, Defense Advanced Research Projects Agency, the Department of Energy, and the National Aeronautics and Space Administration; and several nongovernment activities.



Investigating radiation detectors in a specially instrumented cryostat

ORGANIZATION AND ADMINISTRATION

The following areas represent broad fields of NRL research. Under each, more specific topics that are being investigated for the benefit of the Naval services and other sponsoring organizations are listed. Some details of this work are given in the *NRL Review*, published annually. More specific details are published in reports on individual projects provided to sponsors and/or presented as papers for professional societies or their journals.

Computer Science and Artificial Intelligence

- Advanced distributed simulations for design and warfighting
- Methods of specifying, developing, documenting, and maintaining software
- Expert systems for resource allocation, signal identification, operational planning, target classification, and robotics
- Machine learning
- Information security
- Virtual reality and interactive visual system
- Distributed interactive simulations

Device Technology

- Integrated optics
- IR sensors
- Electric field coupling
- Radiation-hardened electronics
- Microwave and millimeter wave technology
- Hydrogen masers for GPS
- Aperture syntheses
- Vacuum electronics
- Parallel scientific libraries, algorithms for massively parallel, shared memory systems
- Digital progressive HDTV for scientific visualization
- High-performance, all-optical networking

Directed Energy Technology

- Laser propagation
- High-power microwave sources
- Pulsed power
- High energy and chemical lasers
- Pulse detonation engines
- Ram accelerators

Electronic Warfare

- Repeaters/jammers, EO/IR active countermeasures and decoys
- EW/C^3CM systems and technology
- Intercept receivers, signal processing, and identification systems
- Expendable autonomous vehicles
- Platform signature measurement and management
- Threat and EW systems modeling and simulation

Enhanced Maintainability, Reliability, and Survivability Technology

- Coatings
- Lubricants and greases
- Water additives and cleaners
- Fire safety and fire suppression
- Laser hardening
- Satellite survivability
- Missile blast survivability

Environmental Effects on Naval Systems

- Meteorological effects on electro-optical system performance
- Air quality in confined spaces
- Solar and geomagnetic activity
- Ionospheric behavior
- Magnetospheric and space plasma effects
- Contaminant transport

Information Technology

- Antijam communication links
- High assurance computer systems
- Information security
- Communication and information theory
- Networking - mobile, local, metro wide area
- Telecommunications - terrestrial, littoral, space
- Switched optical networking
- Distributed applications
- Battle management information systems
- High performance computing
- Next-generation signaled optical network architecture
- Teraflop scalable shared memory
- Massively parallel computer architectures
- Distributed, secure, and mobile information infrastructures
- High-end, progressive, HDTV imagery distribution
- Satellite and space communication systems
- Voice/data compression technology
- Medium- and high-frequency propagation research
- Shipboard electromagnetic interference mitigation technology

Marine Geosciences

- Geoacoustic modeling
- Marine seismology
- Geomagnetic modeling
- Geotechnology/sediment dynamics
- Geospatial information systems

Materials

- Bio-corrosion
- Biomolecular engineering
- Theory of materials
- Mobility fuels/explosives/propellants
- Materials processing
- Advanced alloy systems
- Rapid solidification technology
- High-temperature materials
- Laser fabrication and processing
- Ceramics and composite materials
- Superconductivity
- Thin films and coatings
- Structural characterization of materials

Meteorology

- Air/sea interaction effects on operations
- Data assimilation techniques
- Global/regional forecasting
- Tactical database development
- Meteorological tactical decision aids

Nanoelectronics and Microelectronics

- Novel, nanostructure-based sensors
- New materials and nano devices

Oceanography

- Open-ocean, littoral, and nearshore oceanographic forecasting
- Shallow water tactical oceanography
- In situ oceanographic sensors and data fusion
- Bio-optical and fine-scale physical processes
- Waves, tides, and surf prediction

Plasma Physics

- Radiation hydrodynamics
- Laser plasma interactions
  - – Pulsed power
  - – Large-area plasma processing
  - – Space plasma simulations

Space Research and Technology

- Advanced space systems
- Space sensing applications
- Remote sensing of the Earth from space
- Satellite communications
- Spacecraft design, engineering, and integration
- Satellite ground station design
- Navigation technology
- Astrodynamics

Surveillance and Sensor Technology

- Imaging radars
- Target classification/identification
- Underwater acoustic propagation, reverberation, and noise
- Electromagnetic sensors–gamma ray to RF wavelengths
- SQUID for magnetic field detection
- Low observables technology

Undersea Technology

- Anechoic coatings
- Fiber-optic acoustic sensors
- Shallow water environmental acoustics and sensor systems
- Target reflection, diffraction, and scattering
- Unmanned undersea vehicle dynamics
- Weapons launch

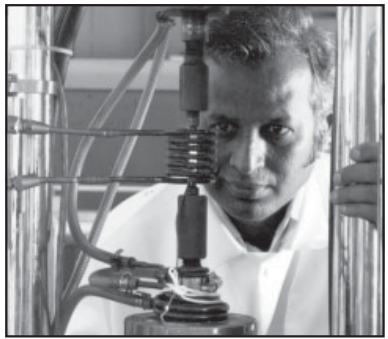
CURRENT RESEARCH

NRL PEOPLE AND PLACES

NRL today employs approximately 2950 personnel—34 military officers, 73 enlisted men and women, and 2843 civilians. In the research staff, there are about 730 doctorate degrees, 334 masters degrees, and 580 bachelor degrees. The support staff assists the research staff by providing administrative help, computer-aided designing, machining, fabrication, technical information services, personnel development, information retrieval, computer support, and contracting and supply management services.

Mosaic view of the near side of the moon lit by earthshine from images transmitted by the Deep Space Science Experiment, called *Clementine*. Designed, built, and operated by NRL, *Clementine* ended the first complete moon mapping in May 1994. NRL donated a model of the *Clementine* satellite to the Smithsonian's National Air and Space Museum on January 22, 2003.

SCIENTISTS/ENGINEERS:	**1581**
Physicists	468
Chemists	116
General Physical Scientists	34
Mathematicians	36
Astronomers	48
Metallurgists	12
Computer Scientists	120
Electronics Engineers	388
Mechanical Engineers	60
Aerospace Engineers	53
Oceanographers	56
Meteorologists	50
Other	140



Evaluating materials at high temperatures under fatigue and creep conditions

Many of NRL's research efforts have spun off commercial applications in addition to the defense-oriented objectives for which they were originally developed. NRL developments in areas such as radar, radio, satellite navigation, fiber optics, chemical and biological sensors, and a wide variety of materials and coatings have made significant contributions to the safety and welfare of the civilian community.

The transitioning of NRL's dual use technologies to the private sector is facilitated by NRL's Technology Transfer Office. This office implements the Technology Transfer Act by which Congress authorized Federal Laboratories such as NRL to participate in Cooperative Research and Development Agreements (CRADAs) and patent licensing agreements. NRL has entered into more than 200 CRADAs with industry, universities, nonprofit organizations, and other government organizations. In addition, NRL has executed over 40 licenses to its inventions. These licenses authorize the licensees to manufacture and sell a product based on NRL's technology in exchange for royalty payments that are shared by the Laboratory and the inventors.

NRL's Technology Transfer exhibit travels to various professional meetings and events around the country as a means to expose industry to NRL's leading edge developments and to encourage collaborations and licensing arrangements that will benefit both NRL and industry.

NRL's Nuclear Quadrupole Resonance (NQR) method of screening for explosives has been licensed by Quantum Magnetics, a division of InVision Technologies. Quantum Magnetics manufactures this equipment for screening luggage and packages at airports and other secure areas.

TECHNOLOGY TRANSFER

THE COMMANDING OFFICER

CAPT David M. Schubert, USN, assumed command of the Naval Research Laboratory in May 2002. A 1977 honors graduate and Trident Scholar of the United States Naval Academy, CAPT Schubert received a B.S. in Physics. Once commissioned, he reported to the Naval Research Laboratory for a summer internship program testing thin-line acoustic arrays. After completing nuclear power and submarine training, he reported in March 1979 to the USS *Hammerhead* (SSN 663), where he served as Communications Officer, Damage Control Assistant, and Operations Officer.

He served as an instructor at Nuclear Power School in Orlando, Florida from April 1982 to March 1984, and then as engineer of the USS *Chicago* (SSN 721). In 1988 he was selected for the MIT/Woods Hole Joint Oceanography program, where he received a Master's degree in Physical Oceanography.

In October 1990, CAPT Schubert reported as Executive Officer on USS *Stonewall Jackson* (SSBN 634). From August 1992 to August 1994, he served on the Joint Staff (J3) as Operations Officer for the National Military Command Center.

CAPT Schubert returned to USS *Chicago* as her Commanding Officer from May 1995 to July 1997. From August 1997 to July 1999, CAPT Schubert served as the Assistant for Plans, Liaison and Assessments for the Submarine Warfare Division of the Navy Staff and then moved to COMSUBLANT as the Assistant Chief of Staff for Warfare Requirements, Planning and Assessments.

From July 1999 to May 2002 he served as the Assistant Chief of Naval Research. There he was instrumental in establishing ONR's Future Naval Capabilities program.

CAPT Schubert's awards include the Legion of Merit, the Defense Meritorious Service Medal, the Meritorious Service Medal, the Navy Commendation Medal, and the Navy Achievement Medal. He twice served on ships that won Battle "E" awards.

Dr. John A. Montgomery received his B.S. in Physics from North Texas State University in 1967 and his Master's in Physics in 1969. He received his PhD in Physics from the Catholic University of America in 1982. As Director of Research of the Naval Research Laboratory, he oversees research and development expenditures of approximately $800 million per year.

Dr. Montgomery joined the NRL in 1968 as a research physicist in the Advanced Techniques Branch of the Electronic Warfare Division. In 1980, he was selected to head the Off-Board Countermeasures Branch. In 1985, he was appointed to the Senior Executive Service (SES) and was selected as Superintendent of the Tactical Electronic Warfare Division. He has been responsible for numerous systems that have been developed/approved for operational use by the Navy and other services and has had great impact through the application of advanced technologies to solve unusual or severe operational deficiencies noted during world crises.

Dr. Montgomery received the DoD Distinguished Civilian Service Award in 2001, the DoN Distinguished Civilian Service Award in 1999, and the DoN Meritorious Civilian Service Award in 1986. As a member of the SES, he received the Presidential Rank of Distinguished Executive award in 1991 and 2002 and the Presidential Rank of Meritorious Executive award in 1988 and again in 1999. He also received the 1997 Dr. Arthur E. Bisson Prize for Naval Technology Achievement, awarded by the Chief of Naval Research in 1998. Further, he has received the Association of Old Crows (Electronic Defense Association) Joint Services Award in 1993. He was an NRL Edison Scholar, and is a member of Sigma Xi. He has served as the U.S. National Leader of The Technical Cooperation Program's multinational Group on EW since 1987, and served as its Executive Chairman.

THE DIRECTOR OF RESEARCH

The following three publications are available from the Publication and Visual Information Services Section, Code 5211, (202) 404-4963.

- The *NRL Fact Book* gives more details about the Laboratory and its operations. It lists major equipment, current fields of research, field sites, and outlying facilities. It also presents information about the responsibilities, organization, key personnel, and funding of the divisions, detachments, and other major organizational units.
- The *NRL Review* presents annual highlights of the unclassified research and development programs. The book fulfills a dual purpose: it provides an exchange of information among scientists, engineers, scholars, and managers; and it is used in recruiting science and engineering professionals.
- *NRL Major Facilities* highlights major research areas to promote cooperative use of these facilities between Laboratory scientists and other agencies.

To date, NRL has signed a significant number of CRADAs and licensed important technology to private industry. Specific information on NRL-developed technology is available from the Technology Transfer Office at (202) 767-7230.

General information about NRL may be obtained from Public Affairs, Code 1030, (202) 767-2541.

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CAPT David M. Schubert, USN
Commanding Officer

URL: http://www.nrl.navy.mil/